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ABSTRACT

This unit consists of four parts. Part 1 contains a five-item instrument designed to help teachers clarify their own views about "burning." Part 2 discusses scientists' views about burning and lists answers to the survey instrument presented in part 1. Part 3 contrasts scientists' views with children's views, using children's comments obtained during the in-depth phase of the Learning in Science Project. Part 4 presents several teaching activities designed to help children modify their views of concepts related to "burning." Activities include: (1) observing a burning candle; (2) investigating the yellow part of a flame; (3) examining the dark, inner part of a flame; (4) investigating candle wax; (5) discovering what happens to wax when a candle burns down; (6) determining if air is needed to burn things; (7) demonstrating that air is used in burning; (8) and determining what is formed when a candle burns. Three extension activities, answers to questions, and an outline of the activities with suggested sequence (in flowchart format) are included. (JN)

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Burning

A Resource Unit for Teachers

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WORKING PAPER No. 36

BURNING THINGS

A RESOURCE UNIT FOR TEACHERS

Brendan Schollum,[1] November 1981

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PART 1 Introduction - your views about Burning

Initially you might ask why teach about burning? We all know that children daily experience things burning, in and out of science classrooms (e.g. using a bunsen burner, having a BBQ, in the workshop). We have found by interviewing children[2] about what they think happens when things burn that some views which are surprising to science teachers are far more common than we would expect. This paper then investigates not only scientists' views of burning but also children's views, and just as importantly, what your views are. Thus we suggest you attempt the survey questions over the page before proceeding into the following 3 sections.

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1 Two teachers Tricia Briscoe and Janet Nairn have contributed to the writing and trialling of this unit also.

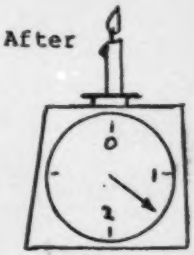
2 The children's views described in this paper are outlined in greater detail in the Learning in Science Working Papers, Particles, No. 18, John Happs and Chemical Change, No 27, Brendan Schollum.

A Survey of some of your ideas of Burning

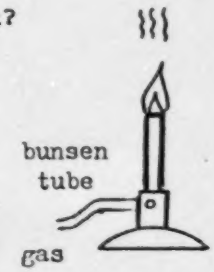
1. When a candle is alight,
   (a) air is needed to help the flame, but none of it is used up.
   (b) part of the air changes into something else.
   (c) air is not needed when a candle burns.

2. Consider what some people say about the wax when a candle burns. In your view, which is the best statement about the wax?
   (a) the wax is burned up in the candle flame
   (b) the wax is not burned up; it holds up the wick as the wick burns
   (c) the wax is not burned up; it melts and stops the wick from burning too fast.

3. A candle is put on the pan of some kitchen scales, and lit. After 60 minutes the reading on the scale would be:
   (a) less
   (b) the same
   (c) more



4. Just above the flame it is <u>hot</u>. What is it that is hot?
   (a) The air only.
   (b) The air and the same gas as that in the bunsen tube.
   (c) The air and at least one gas that is different from that in the tube.



5. Answer <u>Yes</u> or <u>No</u> to each of the following and give a reason why you think that way. In your meaning of the word <u>burning</u> would you say that:
   (a) petrol is <u>burning</u> when it is used to make a car go?
   (b) a sparkler is <u>burning</u> when it is alight?
   (c) a light bulb is <u>burning</u> when it is on?
   (d) coal is <u>burning</u> when it is smoldering?

PART 2 A Scientist's View about Burning

What happens when substances burn is not easily explained, nor is it easily understood. Basically, burning is a rapid reaction involving a substance mixing with oxygen gas (or air) where both the substance and oxygen break up and are rearranged so that new substances are formed. These new substances are normally carbon dioxide and water in its gaseous form. Evidence of heat and light (sensed by the presence of a flame) usually confirm that a substance is burning but this is not always true. For example, in an incandescent light bulb, the filament glows white hot because of its electrical resistance, but it is not reacting with oxygen or any other gas.

Consider what happens as a candle burns. When a lighted match is brought near an unlit candle, the heat from the match flame causes the solid candle wax on the wick to melt, then evaporate. At a particular temperature (the ignition temperature) the gaseous wax particles and the oxygen particles break down and are rearranged. The overall reaction is exothermic, that is energy is released giving heat and light (the flame). Some of this energy is used to melt some of the solid wax which is then drawn up the wick (like ink drawn up blotting paper), where the heat of the flame causes it to evaporate also. A little of the melted wax may ooze down the sides of the candle.

A similar reaction is that between the gas of a gas bottle and the oxygen of air.

We should really look at all possible reactions of substances with oxygen. There is a variety of terms used depending on the nature and temperature of the various substances involved. This range of terms can be shown diagrammatically.

Reaction

fast			slow
exploding	burning	smoldering	corroding
e.g. oxygen plus:			
hydrogen gas	wood candle wax coal	coal silage compost	iron (plus moisture) copper

All of these are examples of oxidation reactions involving oxygen. The terms exploding and smoldering indicate special conditions involving burning. You can put a match to petrol in an evaporating dish and it burns. Petrol burns too, in a car engine but it is an explosive reaction because the petrol is in the gaseous state and well mixed with oxygen before a spark is introduced to the cylinder containing the mixture.

Iron corrodes slowly, but if we were to heat iron first until it glowed, and then place it in a bottle of oxygen gas, the reaction is so vigorous that the iron burns brilliantly, throwing off sparks of iron oxide. Thus it is vital to consider the conditions under which a substance is mixing with oxygen, and this gives some indication of likely products. After all, if a flame is put to acetylene gas that has been made in a science laboratory, a sooty flame results (soot includes small particles of carbon). This appears different from children's experiences of the very hot clear flame from the oxyacetylene torch in the engineering workshops. In both cases the acetylene is burning but the conditions under which it is burning can and do vary. In all cases given above, the reactions are exothermic. This means that overall, energy is released during the actual reactions.

'Burning' should not be confused with 'decomposing'. Some substances decompose when heated e.g. sugar, bread, ammonium dichromate. However, in the case of substances containing carbon which decompose to carbon and water, the temperatures involved are high enough to enable the carbon to burn to carbon dioxide. Hence a flame can be seen, as the sugar decomposes and then burns.

Summary of responses

1. b
2. a
3. a
4. c
5. a) Yes
   b) Yes
   c) No
   d) Yes

PART 3 Children's Views about Burning

Aspects of children's views about burning have been investigated using examples familiar to children. We can summarise children's views by contrasting their views with scientists' views about burning. Note that not all the children's views are likely to be held by any one child. Page numbers are used to show the context within which the views were given.

Children's views	contrasted with	Scientists' Views
Air is not actively involved in burning (P 7, 8, 13)		Air is actively involved when most things burn.
A substance is not used up when it burns (P 7, 12, 13)		A substance is used up when it burns.
A substance called heat is formed when substances burn (P 7)		Heat is not a substance, it is a form of energy.
No new substances are formed when substances burn (P 7)		New substances like carbon, carbon monoxide, carbon dioxide, and water vapour are formed when substances burn.
A substance which goes brown when heated has been burnt (P 9)		When heated, some substances form products which are brown or black. They have not necessarily been burnt.
A substance burns when it evaporates (P 10)		Burning is not the same as evaporating.
Things that burn are not made up of particles (P 11)		All matter is made up of particles.
There are no particles in a flame (P 11, 12)		There are all sorts of particles in a flame as well as the heat and light we sense.
Particles can be destroyed in a flame.		Atomic particles are never destroyed in a flame.

These views are now considered in more detail. The data was obtained from 36 students (1 x F1, 7 x F2, 8 x F3, 7 x F4, 5 x F5, 6 x F6, 2 x TC)[3] interviewed about the gas burner (section 3.1) and the

3. 8 x F3 means 8 Form 3 pupils. TC refers to primary teachers college students.

sugar (section 3.2). 41 students (3 x S4, 1 x F1, 5 x F2, 7 x F3, 9 x F4, 5 x F5, 3 x F6, 6 x F7, 2 x TC) were interviewed about the burning candle (section 3.3). Survey information involving larger samples of pupils were used to back up the findings.

In the first two events described, the emphasis was placed on the children's view of what was seen happening, what they thought was happening and what was formed. In the example of the candle burning, the children's views of what the wax was made of and what the flame was made of was explored.

3.1 Gas Burner

A butane gas burner was used. Most pupils correctly categorised the burner immediately it was produced suggesting some familiarity with the appliance. Once the gas had been lit, questions such as "What do you notice?", "What is your view of what is happening?", "What is up here?" (pointing to above the flame) were asked.

The presence of a flame was a strong idicator to the 36 interviewed that the gas had changed in some way. But only nine pupils (2 x F3, 4 x F4, 2 x F5, F6) suggested that oxygen or air was involved in the production of a flame. Eighteen of the others were asked: "Is anything else involved here?" Nine (F1, 2 x F2, 2 x F3, F4, 2 x F5, TC) answered "No" and nine (2 x F2, F3, 2 x F4, F5, 2 x F6, TC) answered 'air' or 'oxygen'. Following this question, in some cases the views that had earlier been expressed were modified. Undoubtedly, some children have the view that while air is involved when something was burning, the view that something might still burn in the absence of air was also held.

There were four categories of views expressed by those interviewed regarding the products formed as a result of the gas burning.

1. When gas is lit or ignited, a chemical change occurs whereby different substances are formed. For example:

> "It's burning up but there are different gases released. When you burn up the gas, different gases are formed and released."
>
> F4, (Also F2, F3, 3 x F4, F5, F6, T)

Three of the sixth formers gave initial statements which superficially appeared compatible with the scientific view of chemical change. However views in conflict with the scientific explanation of the process were revealed after further questioning. For example, one pupil thought that probably carbon dioxide and hydrogen were formed, but then said that oxygen and butane particles join together and "they just stay joined". Another pupil had the view that the flame caused the butane gas molecules to break up; then they were released into the atmosphere. The other pupil's view was expressed in this way.

> "The gas is coming out where it mixes with the oxygen, then it burns. (Burns?) The oxygen is leaving. It's splitting up from the other gas molecules. (What's up here?) Heat and the oxygen ... that has been split up."
>
> (F6)

2. Gas only is involved in making the flame, and this results in burnt gas, or 'something'. For example:

> "The gas is eating up, no, the flames are eating up the gas. The gas is what supplies the flame to keep it going. (What happens when it eats up the gas?) It eats it up and then it goes up in little pieces. (Is this the flame going up or something else?) Burnt gas or something, and heat."
>
> F3, (Also F1, 2 x F2, 2 x F3, 4 x F4, 2 x F5)

Four of these pupils described the 'something' as soot or smoke.

3. Gas turns into heat. Many pupils mentioned heat as the only product. Their meaning for the word 'heat' was explored. The six pupils in this category considered that heat was the product of the gas burning. For example:

> "(What do you mean by burnt?) It passed through something which made it hot. The gas is vulnerable to heat. (Put that another way.) The heat mixes with the gas and makes a flame. (Does the gas change into a flame, or does it pass through, or ...?) It changes into a flame. (What happens further up?) It turns into heat or heat waves."
>
> F2, (Also 4 x F3, F5, F6, TC)

Two of the pupils (F5, F6) mentioned that air also was involved in the above process. The Teachers College student said there was a reaction occurring, but all the gases may not be 'combusting'. Then:

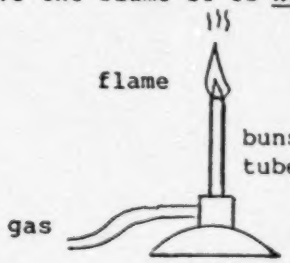
"(What happens to the gas that combusts?) It's utilised as heat. It's just gone, forming energy ... or is it? (Is anything else involved?) ... Just the pressure."

4. Gas above the bottle is similar to the gas in the bottle. Three Form 2 pupils held the view that the gas above the flame was not really different from that in the bottle. For example:

"(Are these fumes the same up here as the gas down here?) Yes, probably. (Has the gas changed?) Yes, a bit because up here its free to go and mix in with the air particles."

Responses to the following survey question clearly indicate the prevalence of this latter view in particular.

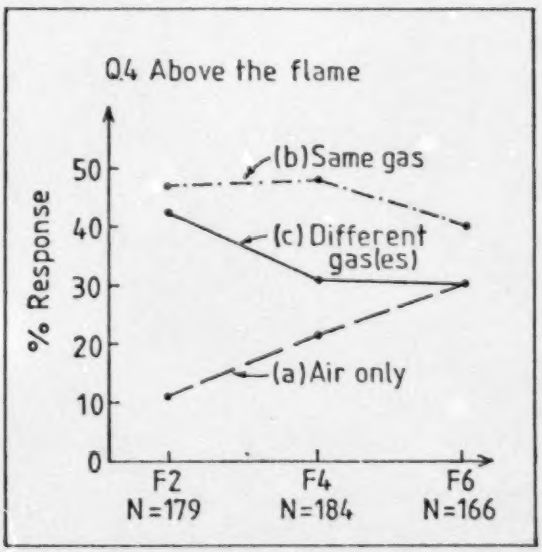
Above the flame it is hot. What is it that is hot?



a. air only

b. air and the same gas as that in the bunsen tube

c. air and at least one gas different from that in the tube



In the sense that the gases formed when butane burns are carbon dioxide and water vapour, and that these substances can be found in air, answers (a) and (c) have some scientific basis. But eight sixth formers who chose answer (a) were questioned individually about why

they made that response. Five mentioned that they had the idea that gas was used up when it burnt, so the flame heated the air above it. One boy said the response "had to be (a) because you couldn't see anything else formed". The other two explained that the products formed were part of air anyway.

3.2 Sugar "Burning"

Some sugar crystals were placed on a spoon and heated over the gas burner. The sugar melted, then changed to a brown frothy liquid giving off clearly visible fumes. Questions such as "What do you notice?", "What is your view of what is happening to the sugar?" initiated discussion. Everyone interviewed used the terms 'melted' or 'dissolved' in describing the change of state of sugar from solid to liquid. Subsequent questions such as "What is your view of what the brown colour is?", "What are the fumes?" were asked.

Unlike scientists who would view the changes as being chemical changes but not involving burning, most children considered that sugar had been burnt. Often they were using an everyday meaning for the words "burning" or "burnt". In terms of what had happened to the sugar, there were just two views expressed by the pupils interviewed.

1. The melted sugar had broken up and new substances were formed. Carbon, steam, and smoke were mentioned as likely products in some cases. Views compatible with the scientific position regarding this process of chemical change were spread through all age groups. For example:

> "(And what's coming off?) Smoke and steam. It could be smoke because it is burning and steam because it is very hot. (Is the smoke sugar?) It's probably parts coming out of the sugar and some of it going up in steam."
>
> F2 girl, (Also F2, 2 x F3, F4, F5, 3 x F6, TC)

Some older students' answers included some chemistry terminology although it was not always used in the appropriate manner. For

"The sugar has melted. And the oxygen trapped in the crystals before, rise to the top to form bubbles. The sugar burns and forms a carbon compound ... the smoke coming off is carbon dioxide and comes from the mixture of oxygen and burning sugar."
(F5)

2. The melted sugar changes to another form of sugar The pupils made such comments as the sugar was 'bubbly, boiling, burning'. When asked for their meanings for those words, and their views of what they had observed happening when the sugar was heated, the following four types of views were evident: The sugar was

(a) in another form which included a colour change, or change of taste (3 x F2, 3 x F3, F4, 2 x F5) or
(b) overcooked but still sugar (F2, F3, F4, F5), or
(c) that colour because it was unable to 'take too much heat' (F1, F2, 2 x F4), or
(d) changed to sugar in the gaseous state (2 x F3, F5).

The views of five pupils fit in more than one of the above categories. The following are examples of the views expressed.

"I reckon the sugar is not made for heat and it won't stand up to it so it has to give way and it melts away and burns. The particles sort of break up and go into a melty burnt substance. (Is that sugar there or is it something else?) It would be sugar but it's not too healthy. It's sugar in a different way." (F3)

"It's dissolved, gone from solid to liquid form. It's kind of fried, gone brown. It's got so hot that it can't take any more so it just got brown." (F4)

"It's probably evaporating. It could be the sugar evaporating." (F5)

In summary, these results suggest that the majority of students viewed the change in the sugar more as a physical change than as a chemical change.

A Burning Candle

Students were presented with a candle held in a glass container and a box of matches, and invited to light the candle.

There followed a fixed sequence of open-ended questions which were supplemented by other questions directed towards aspects of the burning candle. The opportunity was provided for students to respond in terms of particle behaviour.

(a) The Wax

The initial questions in the interview attempted to ascertain whether, or not, children envisaged wax as consisting of particles and if they considered movement of these particles in the solid wax and/or in the molten wax.

When asked what the tiniest bit in the wax was like, 13 students (S4, 3 x F3, 3 x F4, F5, 2 x F6, F7, 2 x TC) included the word 'particle' in their response. Others appeared to have particulate ideas and talked about 'grains' (S4, F1); 'crumbs' (F3); 'the little bits of matter of which it is made up' (S4, F4); 'cells' (F4); and 'atoms' (S4, 2 x F3, F4, 3 x F7). The remaining 15 students gave responses which indicated no real appreciation of a particulate nature for the wax.

(b) The Flame

The question: "What bits are in there in the flame?" produced a broad range of answers.

(i) Twenty students, of all ages (2 x S4, F1, 5 x F2, 4 x F3, 2 x F4, 2 x F5, 3 x F7, TC) envisaged no particles in this region.

Some of these students saw the flame as being made up of successively smaller flames.

> "It would be like a miniature size of the big flame". (F3)
>
> "A whole lot of little ones ... moving up and down like a big flame". (F3)
>
> "The flame would be made up of little flames". (F2)

(ii) Twenty-one students (S4, 3 x F3, 7 x F4, 3 x F5, 3 x F6, 3 x F7, TC) also considered that particles might be found in the flame. There were a number of descriptions of what these particles would be and of their possible origin.

"Burnt little bits drop off". (F4)

"Pretty small bacteria". (F2)

"Oxygen from the air". (F3)

"The match ... they (particles) must have started from the match somewhere". (F5)

"hydrogen particles ... from the air". (TC)

The idea of a hydrocarbon gas being in the flame was offered by 2 students (2 x F7).

c. <u>The Purpose of the Wax</u>

Other students interviewed gave a variety of responses in answer to the question "What's the wax there for?" Several different views were expressed:

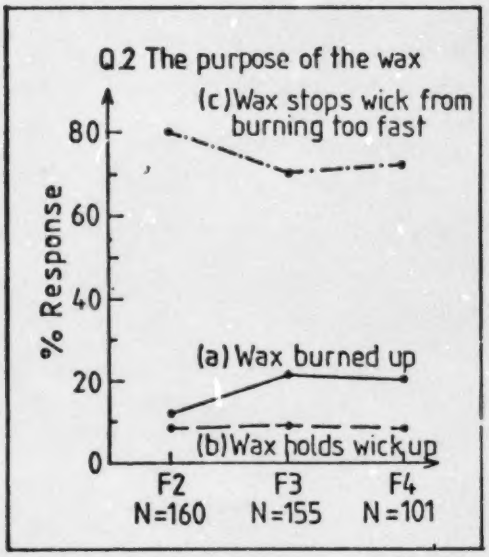
"The wax is the fuel that feeds the flame. It makes the flame."

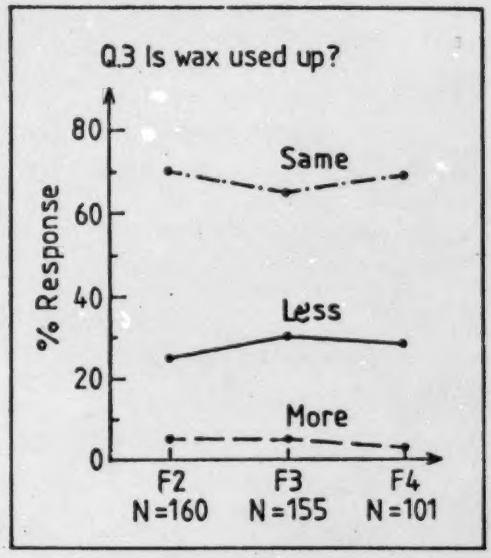
"The wax is there to hold the wick up as the wick burns. It's the wick that burns."

"The wax is just there to stop the wick from burning too fast."

The prevalence of such views were determined by using two survey questions. After all, if children do consider that wax is not used up as a candle burns, it follows that they will consider that the candles mass will remain constant (given that the wick may get shorter in that time).

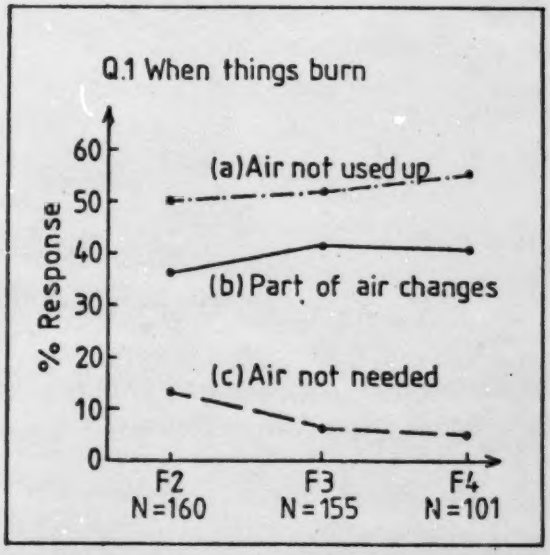
For the precise questions check on questions 2 and 3 of the survey at the beginning of this paper.





(d) <u>The involvement of air</u>

A further survey question was used to determine if and how air is involved when something burns. Refer to survey question No. 1.



PART 4 SUGGESTED TEACHING ACTIVITIES

There is no doubt that some children of all ages are not clear about what is happening when things are burning. The activities outlined here draw heavily on activities outlined in Integrated Science Bk 2, the Wreake Valley Project (editors Tinbergen and Thorburn and published by Edward Arnold). This material is used with the publishers permission. The activities are chosen because they take account of children's views. The activities are clearly set out, and are suitable for children of a wide range of activities. You may like to obtain copies of these resource books (3 volumes) from Edward Arnold's New Zealand agents Book Reps N.Z. Ltd, P.O. Box 36-105, Northcote, Auckland.

The unit is set out so that full pages can be lifted out and copied for use with classes.

The benefits of using a unit such as this is that children can find out so much about chemical reactions, including the nature of substances involved, varying products depending on the reaction conditions; but they find these out incidently, and using something familiar (a candle burning) rather than imposed by "strange people working with strange materials, in a strange room, during science classes".

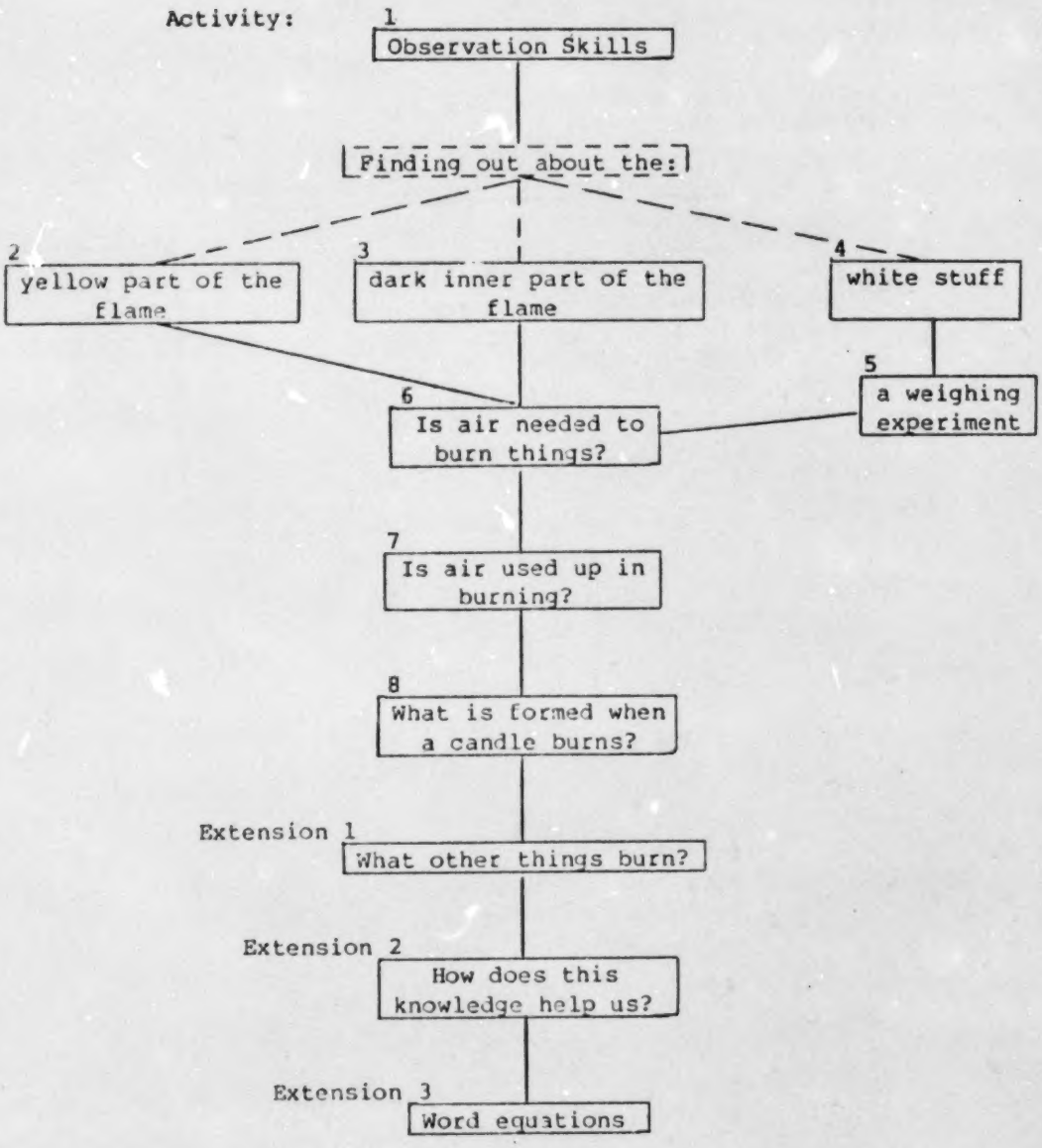
Some organisational matters

1. This unit can require a large supply of candles. However candles do not have to be left burning needlessly.

2. Children can work at their own rates in this unit; but you must decide: how you will group the pupils - individually, - groups
: if the whole class need practice in some of the skills encountered during the unit e.g. observation, as distinct from deductions/recall; measuring volume; measuring time

An outline of the activites and a suggested sequence is shown in the diagram.

A CANDLE BURNING



A CANDLE BURNS

Make a big heading in your books

This should be an enjoyable unit

We want to find out as much as we can about burning using a burning candle as an example. We want to find out:

We want to find out:

1. What really happens when something burns
2. Why there is a flame
3. Is air needed for things to burn? Why?
4. Is anything left over, or made when something burns
5. What sorts of things burn
6. How does all this information help us.

Copy all this

ACTIVITY 1

Testing your skill in observation

What to do

Collect a candle and light it.

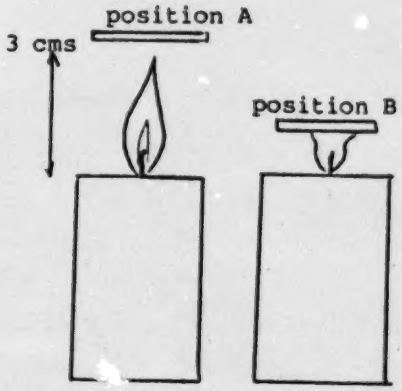
What to write

Put down the date and title of this unit.

1. How much detail can you see? Draw a full page diagram of the candle burning, and label as many different parts as you can see.

ACTIVITY 2

Finding out about the yellow part of the flame



What to do

a) Collect a candle and white tile.

b) Light the candle and then hold the tile in position A for about 10 seconds.

c) Look carefully to see if anything has been left on the tile from the flame.

d) Now hold the tile in position B for 10 seconds and then look at the tile again.

What to write

Write down the date and title of this activity.

1. Describe anything that has been left on the tile after it has been held in position A for 10 seconds.

2. Describe what was left on the tile when it was held in position B for 10 seconds.

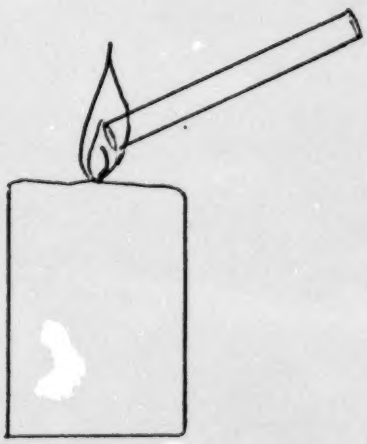
3. Is there more left on the tile at position B than at position A?

Discussion

	Your view	Your group's view	The scientist's view
1. What is the stuff on the tile? 2. Where did it come from? 3. What is in the yellow part of the flame?			

ACTIVITY 3

Finding out about the dark inner part of the flame

What to do	What to write
(a) Collect a candle and a piece of glass tube. Make sure the glass tube is clean before you use it.	Write down the date and title of this activity.
(b) Light the candle and leave it to burn for 1 or 2 minutes.	1. Draw a large diagram to show what you saw during the experiment.
(c) Hold the end of the glass tube in the candle flame, in the sort of position shown in the diagram, and note carefully what you see inside the glass tube.	2. Is there any carbon in the dark part of the flame?
(d) Look at the tip of the glass tube that was in the dark inner part of the flame, and note if anything is left on it.	3. What do you think the stuff formed inside the tube was? Do you think it is smoke, or is it something else? (If you cannot answer this question yet, go on to the next experiment and try to answer this question later.)
	4. You found that there was a lot of carbon in the yellow part of the flame but not much carbon just above the flame. What has happened to the carbon that makes it disappear like this?

ACTIVITY 4

What is the white stuff

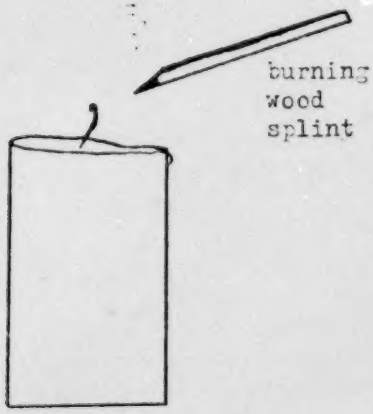
* Information
Do this experiment carefully. If it does not seem to work, ask your teacher about it.

What to do

(a) Collect a candle and wood splint

(b) Light the candle and let it burn for about 2 minutes.

(c) Light the wood splint, and blow out the candle. Immediately, bring the burning splint slowly towards the candle from about 3cm away.



What to write
The date and title of this activity.

1. Describe what you see spiralling away from the candle when it is first blown out?

2. What happened when the splint was brought towards the candle?

3. Does the spiralling stuff burn?

4. Does the spiralling stuff look similar to the white stuff in Unit 3?

5. What do you think the white stuff is?

   i. Is it gas, liquid or solid?

   ii. Does it burn?

   iii. Does it come from the air or the candle?

* Information
The white stuff is vapourised candle wax. Vapourised means 'turned into gas'.

The heat from the candle flame melts the wax and then turns it to gas so that it can burn.

What to write

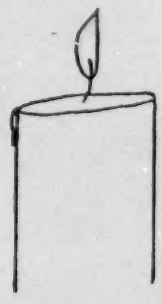
6. Copy this diagram.

Mark in it:

   i. Where the candle wax melts.

   ii. Where the candle wax changes to vapour (gas).

   iii. Where the candle wax vapour is burning.



ACTIVITY FIVE

What happens to the wax when a candle burns?

Initial class discussion:

Check the responses you gave to questions 2 and 3 of the survey.
Do you still hold those views?
How could you find out the opinions of all your class?
Check the total of each response given for questions 2 and 3.
How could you set up an experiment to determine who is right?
You should complete the activity below, either individually or as a group.

WHAT TO DO.

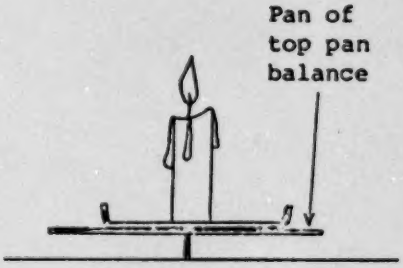
(a) Collect:

a petri dish
a candle
a piece of graph paper

(b) You will need to use the top pan balance during the experiment, so make sure this is available.

(c) You will also need a means of measuring time. The second hand of a watch will do.

(d) Stand the candle in the petri dish on the top pan balance and make a note of the mass of the apparatus.



(e) Draw and complete the the table below

Time (mins)	Mass
0	
1	
2	
3	
4	
5	
6	

(f) Light the candle and take a reading of the mass of the candle each minute

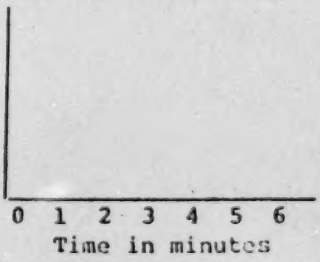
What to write

1. The date and heading of this activity.

2. What you think happens to the wax when a candle burns.

3. Copy the axes for a graph and plot the measurements you have made.

Readings of candle taken



4. In one or more sentences explain what this activity has told you about the wax of a burning candle.

ACTIVITY SIX

Is air needed to burn things

Class discussion

Refer to the responses given to question 1 of the survey.

Does anyone want to change his/her view?

Note that the purpose of this activity and the next one is to make clear your views about air and burning?

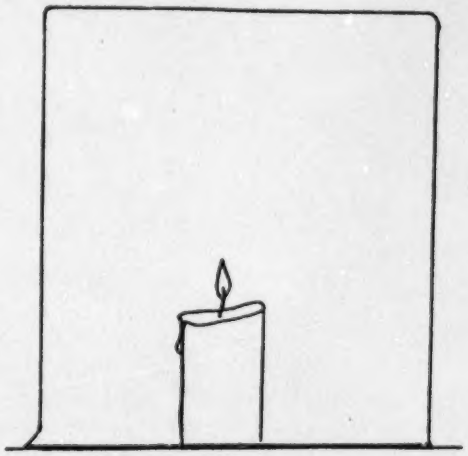
What to write

Write down the date and title of this activity.

1. Draw Table

Table

Volume of the beaker	Length of time the candle burns
100 cm^3	
250 cm^3	
500 cm^3	



What to do

(a) Collect a candle, 3 beakers of different sizes, and you will need some means of measuring time in seconds.

(b) Light the candle and place one of the beakers over the top of it. Note how long in seconds it takes before the candle goes out.

(c) Write your result in the table and then repeat the experiment with the other two beakers.

What to write

2. In which beaker does the candle burn for the longest?

3. Why do you think the candle burns for the longest time in the largest beaker?

ACTIVITY 7

Showing air is used up in burning

* Information

From the experiment in Activity 6 you learnt that a candle needs air in order to burn.

The more air it has, the longer it burns.

Your teacher will show you an experiment that uses this apparatus.

What to write

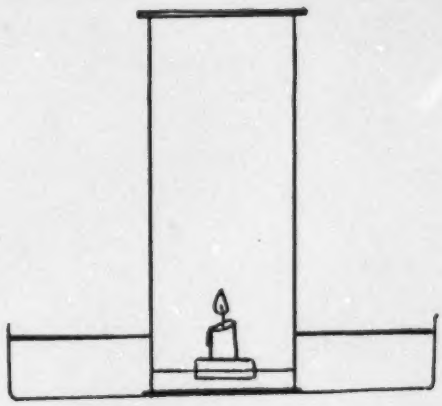
Write the date and title of this activity.

1. Draw a diagram of what the apparatus is like before the experiment.

2. Draw a diagram of what the apparatus is like at the end of the experiment.

3. Explain how this experiment shows that air is used up as the candle burns.

4. Is all the air used up?



ACTIVITY 8

What is formed when a candle burns?

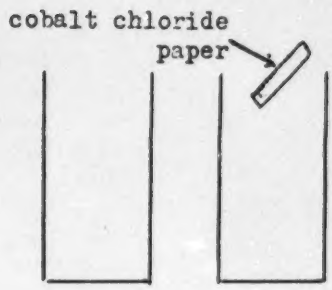
What to do

(a) Collect:
a candle
a gas jar
a gas jar cover

What to write
Write down the date and title of this activity.

1. What is the test for carbon dioxide?
2. What is the test for water?

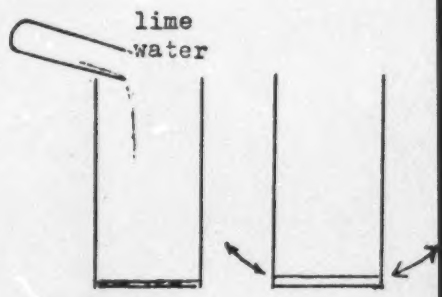
What to do



(b) Light the candle, and place the gas jar over the top of it.

(c) As soon as the candle goes out, turn the gas jar upright and put the cover on it.

(d) Test the gas jar to see if it now contains water by gently running a piece of dry cobalt chloride paper over the mistiness on the side of the gas jar.



(e) Test the gas jar for carbon dioxide by pouring about half a test tube of clear lime water into the gas jar and shaking it a moment or two.

What to write

3. Describe the appearance of the sides of the gas jar after the candle had burnt inside it.

4. As a candle burns it gives off two gases. What are these two gases?

5. Now fill in the answer sheet on the next page <u>or</u> copy out the 3 right hand columns and answer the questions in your own words. If you get into difficulties ask your teacher to help you.

Questions	What you think	What your group thinks	What you think (if you change) after class discussion
1. Flames are made of two parts. In the candle, what do the two parts consist of? (What substances are in the two parts of the flame?)			
2. It is the yellow part of the flame that gives out the light, and chemists have discovered that it is made of tiny specks of soot that are glowing white hot. What is the chemical name for this soot.			
3. You found that two gases were produced by the candle. Carbon dioxide is a gas made of carbon and oxygen. Water vapour is made of the two substances hydrogen and oxygen. i. Where did the carbon come from that made the carbon dioxide? ii. Where did the oxygen come from that made carbon dioxide? iii. Where did the hydrogen come from that made the water? iv. Where did the oxygen come from that made the water?			
4. You found that there was a lot of carbon in the yellow part of the flame but not much carbon just above the flame. What happened to the carbon that makes it disappear like this?			
5. What form of energy is being used up as a candle burns and what forms of energy are being produced?			

EXTENSION 1

Burning Some More Things

What to write

1. Write down the date and title of this extension work.

2. Draw up a chart similar to that one below and put in the names of 6-8 things you would like to test to see if each one burns. Check this list with the teacher.

3. Before getting a sample from the front desk, write in the second column what you think will happen when the material is placed in a bunsen flame.

4. Write in your observations as you carry out each activity (The first one is completed for you).

Name	What I think will happened	What I saw	What I think happened
2 cm of magnesium metal ribbon	It will glow red hot	After about 10 sec, there was a brilliant white flame which lasted about 3 sec a white powder was left	The magnesium burnt with the oxygen in the air to form a new substance
cotton wool			
orange peel			
gladwrap			

EXTENSION 2

How does a knowledge of what things burn help us

It should be easy to write down different substances which burn, and how this helps us. Try to add more than five examples to the two below.

The substance which burns	How it helps us
1. Gas	It provides heating for homes.
2. Acetylene	It is used in oxyacetylene torches for welding
3.	
4.	

Teacher: this is an appropriate time to mention whether light bulbs burn or not. Refer to P 3)

EXTENSION 3

Word Equations

Information:

We can write word equations (like equations of symbols in Maths) to summarise what happens when things burn.

Examples:

1. wax particles + oxygen particles -- carbon dioxide particles + water particles + heat and light (energy)

2. from a gas bottle or oxyactylene torch:

   gas particles + oxygen particles -- carbon dioxide particles + water particles + heat and light (energy)

   We can summarise this chemical reaction even further

3. gas + oxygen -- carbon dioxide + water + energy

   or even further using symbols

4. $C_4H_8 + 6O_2 \text{ -- } 4CO_2 + 4H_2O$ + energy

   C_4H_8 means 4 carbon particles and 8 hydrogen particles are joined together to make one particle of a gas called butane. When we turn on the gas millions of these spread out and mix the air before they burn i.e. change ....

Survey

A week or more after the completion of this unit, give the survey again as well as questions you have made up. Use the children's responses as a further opportunity to clarify any confusion that still exists.

APPENDIX

Answers

Note that these answers are suitable but there may be alternative ways of expressing them.

Activity 2 The Scientists' View

1. The black stuff left on the tile is called carbon.
2. It came from the candle wax.

Activity 3 Finding out about the dark inner part of the flame

3. Very little (this can be confirmed using a wooden splint
4. It has changed into something else.

Activity 4 What is the white stuff

Qu 1. White stuff
2. The flame went down the white stuff and relit the candle.
3. yes
4. yes
5. i) Gas ii) Yes iii) The candle

Activity 5 What happens to the wax when a candle burns

Qu 2,4 The wax has melted, then changed to a gas, and then the wax burned. The wax is used up when a candle burns.

Activity 6 Is air needed to burn things

Qu 2. 500cm^3 beaker
3. There is more air (or oxygen) in the largest beaker.

Activity 7 Showing air is used up in burning

Qu 3. The water rose up to replace the air used.
4. No, (because the water did not rise to the top of the gas jar).

Activity 8 What is formed when a candle burns

Qu 1. The dark part contains vapourised candle wax. The yellow part has burning candle wax vapour and carbon.
2. Carbon
3. i) the candle wax
ii) the air
iii) the candle wax
iv) the air
4. It changed into colourless carbon dioxide gas.
5. Stored (potential) energy to heat and light.

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